INDOOR AIR QUALITY ASSESSMENT

Wellesley High School
50 Rice Street
Wellesley, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
November 2004

Background/Introduction

At the request of the Wellesley Health Department, the Massachusetts Department of Public Health (MDPH), Center for Environmental Health's (CEH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality at the Wellesley High School (WHS) 50 Rice Street, Wellesley, Massachusetts. On March 2, 2004, a visit to conduct an indoor air quality assessment was made to this school by Mike Feeney, Director of BEHA's, Emergency Response/Indoor Air Quality (ER/IAQ) Program. Mr. Feeney was accompanied by Cory Holmes and Sharon Lee, Environmental Analysts' in BEHA's ER/IAQ Program.

The school is a three-story brick building constructed in 1938. Additions to the building were made in 1956 and in 1964. Portions of the building underwent renovations in 1990. The third floor contains general classrooms, specialty classrooms, music rooms and the language lab. The second floor is made up of general classrooms, alternative classrooms, and music rooms. The first floor contains the auditorium, library, theatre, student center the upstairs gymnasium and office space. The ground floor is occupied by art rooms, a second gymnasium and locker rooms, dark room and photo lab, the dance/wrestling room, cafeteria and kitchen, TV studio, science labs and shop areas. According to Dana Cotto, Director of Buildings and Grounds, Wellesley Public Schools, plans for a roof replacement had begun.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Screening for total volatile organic compounds

(TVOCs) in science areas was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID).

Results

This school houses grades 9-12 and has a student population of approximately 1,100 and a staff of approximately 200. Tests were taken during normal operations at the school and results appear in Table 1.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million of air (ppm) in thirty-six of eighty-eight areas surveyed, indicating inadequate ventilation in a number of areas. Fresh air in classrooms is supplied by a unit ventilator (univent) system. The majority of univents appear to be original equipment, which had reportedly been serviced and had parts replaced over the years. Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (Picture 1) and return air through an air intake located at the base of each unit (Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through an air diffuser located in the top of the unit. During the assessment, a number of univents were observed to be not operating or had been deactivated. Obstructions to airflow, such as papers and books stored on univents and items in front of univent returns were seen in a number of classrooms (Picture 2). In order for univents to provide fresh air as designed, these units must remain activated and allowed to operate while these rooms are occupied. Air diffusers and return vents must

also remain free of obstructions. Classroom 316 does not have windows or mechanical ventilation; nor does the room have passive ventilation for air exchange.

Exhaust ventilation in classrooms consists of ceiling or wall-mounted vents powered by rooftop motors (Pictures 3 and 4). Exhaust ventilation in the 1938 portion of the building is provided by exhaust vents located in ungrated floor level "cubby" holes. These vents were being used for storage throughout the wing, thereby obstructing airflow (Picture 5). The exhaust system was not drawing and/or was backdrafting in a number of areas surveyed, indicating that motors were either deactivated or non-functional. As with the univents, exhaust vents must be activated and remain free of obstructions to function as designed. Without adequate exhaust ventilation, excess heat and environmental pollutants can build up and lead to indoor air complaints.

In order to have proper ventilation with a mechanical supply and exhaust system, ventilation systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing of these systems was not available at the time of the assessment.

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information on carbon dioxide see Appendix A.

Temperature readings ranged from 71 ^{o} F to 81 ^{o} F, which were within the BEHA comfort guidelines the day of the assessment, with one exception, the wrestling room. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} F in order to provide for the comfort of building occupants. A number of temperature control/comfort complaints were expressed by occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. It is also difficult to control temperature and maintain comfort without operating the ventilation equipment as designed (e.g., univents and exhaust vents obstructed/not operating).

Relative humidity measurements ranged from 25 to 46 percent, which were below the BEHA comfort range in the majority of areas. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A number of areas had water-stained ceiling tiles, which can indicate leaks from the roof, heating/steam pipes or plumbing system (Picture 7). According Mr. Cotto, the boiler system was replaced a number of years prior to this assessment. Mr. Cotto reported the boilers were connected to the existing heating pipe system. In the experience of BEHA staff, attaching a new boiler plant to an existing pipe system can produce steam leaks through pipe joints due to the increase of efficiency and steam pressure. A number of water damaged or missing ceiling tiles were located directly beneath leaking heating pipe joints. As each joint is repaired, Mr. Cotto reports that another leak occurs in joints in another part of heating system. The repair on the original leak joint then transfers pressure to other parts of the pipe system, which produces a breach at the next weakest joint. Water-damaged porous building materials can provide a source for mold and should be replaced after a water leak is discovered and repaired. Where leaks are noted, removal of water damaged materials is recommended to prevent mold growth.

This assessment of the WHS was prompted due to a leak from a tank located in the basement of the building (Picture 8). At the time of this assessment, the leak from this tank had been repaired and the area was cleaned. No residual water damage to building materials or mold growth from this incident was present.

Signs of bird roosting and nesting were observed in a number of recesses around the exterior of the building (e.g., overhangs, building envelope penetrations) (Picture 6). Birds can be a source of disease, and bird wastes and feathers can contain mold, which can be irritating to the respiratory system.

Certain molds are associated with bird waste and are of concern for immune-compromised individuals. Other diseases of the respiratory tract may also result from chronic exposure to bird waste. Exposure to bird wastes is thought to be associated with the development of hypersensitivity pneumonitis in some individuals. Psittacosis (bird fancier's disease) is another condition closely associated with exposure to bird wastes in either the occupational or bird rearing setting. While immune-compromised individuals have an increased risk of health impacts following exposure to the materials in bird wastes, these impacts may also occur in healthy individuals exposed to these materials. The protection of both the cleaner and other occupants present in the building must be considered as part of the overall remedial plan. Where cleaning solutions are to be used, the “cleaner” is required to be trained in the use of personal protective methods and equipment to prevent either the spread of disease from the bird wastes and/or exposure to cleaning chemicals. In addition, the method used to clean up bird waste may result in the aerosolization of particulates that can spread to occupied areas via openings (doors, etc.) or the ventilation system.

Small trees and other plants were also seen growing against the foundation (Pictures 9 and 9A). The growth of roots against the exterior of foundation walls, as well as spaces between the tarmac, can bring moisture in contact with brick and foundation, which may eventually lead to moisture penetration below ground level areas of the building. The exterior walls had spaces/utility holes in brickwork (Pictures 10 and 11). These conditions are breaches of the building envelope and provide a means for water entry into the building. Repeated water penetration can result in the chronic wetting of building materials and the potential for microbial growth.

Several classrooms had a number of plants. Moistened plant soil and drip pans can be a source of mold growth. Plants should be equipped with drip pans. Plants are also a source of pollen. Several classrooms had plants in close proximity to univents (Picture 12). Plants should be located away from the air stream of ventilation sources to prevent the aerosolization of mold, pollen or particulate matter throughout the classroom.

Other Concerns

A number of areas throughout the building contained conditions that can result in the aerosolization of irritating materials into the school environment. In addition to repairing the ventilation system, the identification, proper storage of, or elimination of these materials would serve to improve indoor air quality in this building.

Of concern is wooden cabinet used to store acids that is placed on top of a flameproof cabinet (Picture 13). This configuration of storage cabinets is of concern because a leak of corrosives from the wooden cabinet would likely corrode the metal flameproof cabinet. Acid vapors appear to have escaped from containers stored in this wood cabinet, as evidenced by

heavy corrosion of door hinges, fasteners and locks. Cabinets used to store acidic materials should be constructed of materials that resist corrosion. In addition flammable materials and corrosives should be separate to prevent accidental mixing of these materials. Certain flammables and corrosive mixtures can react violently if mixed.

Other problems noted in the science area which are or can be a fire and/or safety hazard include:

1. Fasteners for shelves and well as metal caps on containers in the chemical storeroom appear to be corroded from off-gassing materials (see Picture 14). Corrosive materials appear to have corroded the metal shelf supports, coating the shelf with oxidized metal. The corroding of the metal shelf supports can lead to the undermining of the structural integrity of the shelves. Corrosive liquid materials should be removed from the shelves and relocated.
2. A highly flammable material, "Thermit", was stored on an open shelf (see Picture 15). This material should be segregated from general storage.
3. Butane cartridges were stored on top of a cabinet.
4. Shelves do not have guardrails to prevent accidental breaks of chemical containers.
5. Food containers are used to store materials.
6. Bottles were sealed with cork stoppers.
7. There are a number of unlabeled containers filled with unknown materials.
8. Containers are labeled with chemical formula only, hindering swift identification of a spilled material in an emergency.

Of note is the storage of water reactive materials. These materials are stored in a classroom closet away from the chemical storage area. This closet is locked, but not labeled, which

would prevent warning of emergency response personnel not to use water to extinguish a fire in this room/closet. A pipe from an undetermined point runs through the water reactive materials storage closet. If a leak were to occur from this pipe or water used to extinguish fire on a level above were to penetrate into the closet, these material could potentially become exposed to moisture and react violently. Water reactive chemical storage areas should be well-labeled and in an area that will limit actual or potential exposure to water in an emergency.

A restricted use pesticide was noted in an area used to collect chemicals for disposal (see Picture 16). Sevin is a carbamate pesticide that can cause serious acute health effects upon exposure and can be readily absorbed through the skin on contact (USEPA, 1989). For these reasons, the US Environmental Protection Agency has classified sevin as restricted use pesticides, which curtails the sale of these materials to the general public and requires that the user of these materials be a licensed restricted use pesticide applicator. Under current Massachusetts law (effective November 1, 2001), the principles of integrated pest management (IPM) must be used to remove pests in state buildings (Mass Act, 2000). Pesticide use indoors can introduce chemicals that can be sources of eye, nose and throat irritation.

It is highly recommended that a thorough inventory of chemicals in the science department and custodial areas be done to assess chemical storage, reduce amounts of chemical s stored and dispose in an appropriate manner consistent with Massachusetts hazardous waste laws.

Several other conditions that can affect indoor air quality were noted during the assessment. The odor of photograph developing chemicals was noted in the basement

hallway outside the darkroom. Stored in the darkroom are a number of photographic chemicals in an area with either non-functional or poorly functioning exhaust ventilation. In addition, local exhaust vents should be located at the level of the wash sink and developing pans to draw odors away from users. The location of the exhaust fan in the exterior wall will tend to draw odors towards users of the wash sink and developing pans (see Figure 2). Photographic chemicals contain volatile organic compounds (VOCs), which can be irritating to the eyes, nose and throat which should be vented from the building.

The technology shop contained a number of activities that require dedicated exhaust ventilation to reduce exposure to aerosolized pollutants. Mechanical grinding, soldering of electrical circuits and cutting/drilling of plastic can all aerosolize respirable vapors and particles which can be irritating to the eyes, nose, throat and respiratory system.

BEHA staff received reports of odors in a classroom (193) above the woodshop. The fresh air is supplied by univents with fresh intakes at the level of the roof above the woodshop. The exhaust vent for the wood shop terminates in a cane vent on the same roof (Picture 17). The location of the cane exhaust vent can lead to vapors and odors from the wood shop to be directed into the classroom univent intake under certain wind conditions. Odors from wood shops and include wood dust and a variety of volatile organic compounds (VOCs) for paints, varnishes and other carpentry related materials. VOCs and wood dust can be irritating to the eyes, nose, throat and respiratory system.

Room 201 contains a photocopier. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, 1992). This room is not equipped with local exhaust ventilation to help reduce excess heat and odors.

Also of note was the amount of materials stored inside classrooms. In classrooms throughout the school, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provide a source for dusts to accumulate. These items, (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Dust can be irritating to eyes, nose and respiratory tract. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up.

Accumulated chalk dust and dry erase board particulate was noted in several classrooms. Several rooms had missing and/or dislodged ceiling tiles. Missing/dislodged ceiling tiles can provide a pathway for the movement of drafts, dusts and particulate matter between rooms and floors. Chalk dust and dry erase board particulates can be easily aerosolized and serve as eye and respiratory irritants. In addition, materials such as dry erase markers and dry erase board cleaners may contain VOCs (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can also be irritating to the eyes, nose and throat.

The wood shop is equipped with floor drains that did not appear to have recently drained water, which can lead to dry traps. A trap forms an airtight seal when water is poured down the drain. A dry trap can allow sewer gas to back up into the building. Sewer gas can be irritating to the eyes, nose and throat.

Finally, during a perimeter inspection of the building, BEHA staff observed several bees/wasps nests on the exterior of the building. Under current Massachusetts law (effective November 1, 2001) the principles of integrated pest management (IPM) must be used to remove pests in state buildings (Mass Act, 2000). Pesticide use indoors can introduce chemicals into the indoor environment that can be sources of eye, nose and throat irritations.

Conclusions/Recommendations

The conditions noted at Wellesley High School raise a number of complex issues. The combination of the design of the building, maintenance, work hygiene practices and the condition of stored materials in the building, can adversely influence indoor air quality in this building. For these reasons a two-phase approach is required, consisting of immediate measures to improve air quality at Wellesley High School and long-term measures that will require planning and resources to adequately address overall indoor air quality concerns.

In view of the findings at the time of the visits, the following **short-term** recommendations are made:

1. Move the water reactive chemical(s) to an area without pipes or other potential water sources. Label storage area sufficiently to warn of water reactive danger.
2. Remove wooden cabinet on top of the flammable storage cabinet and move acids to a location away from organic chemicals and water. Obtain a corrosion-resistant storage cabinet for storage of acids.
3. Survey classroom univents to ascertain function and determine whether an adequate air supply exists for each room. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers throughout the school.
4. To maximize air exchange, operate all ventilation systems throughout the building (e.g., gym, auditorium, classrooms) continuously during periods of school occupancy

independent of thermostat control. To increase airflow in classrooms, set univent controls to "high".

5. Inspect rooftop exhaust motors and belts for proper function, repair and replace as necessary.
6. Remove all blockages from univents and exhaust vents.
7. Consider having ventilation systems re-balanced every five years by an HVAC engineering firm.
8. Continue to remove water damaged ceiling tiles from the ceiling where steam pipe leaks occur.
9. Install a passive door vent in classroom 316 to facilitate air exchange.
10. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all non-porous surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
11. Examine methods for directing wood shop exhaust vent odors away from classroom univent fresh air intakes. This may include extending the vent upwards or over the side of the roof.
12. Repair the exhaust ventilation system in the darkroom. Operate the exhaust ventilation continuously to prevent the accumulation of photographic chemical odors in the darkroom of hallway.

13. Contact a pest management consultant firm to remove birds' nests and wastes from the building. To prevent possible exposure to bird wastes, implement the corrective actions recommended by the CDC (CDC, 1998). To prevent possible spread of bird waste particulates to occupied areas, employ the methods listed in the SMACNA guidelines for Containment of Renovation in Occupied Buildings (SMACNA, 1995).
14. Seal holes/breaches in exterior walls to prevent water intrusion.
15. Ensure plants have drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary. Keep plants away from the air stream of univents.
16. Remove foliage to a minimum of five feet away from the foundation. Trim trees in rear of building that overhang the roof. Ensure univent air intakes on the exterior of the building are free of obstruction.
17. Examine the feasibility of installing local exhaust ventilation for photocopiers or move to a well-ventilated area.
18. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
19. Improve to ventilation to remove photography developing chemical odors from building.
20. Provide exhaust ventilation for grinding, soldering and plastic cutting activities.
21. Clean chalkboards and dry erase board trays regularly to avoid the build-up of particulates.

22. Use the principles of integrated pest management (IPM) to rid the building. A copy of the IPM recommendations can be obtained from the Massachusetts Department of Food and Agriculture (MDFA) website at the following website: http://www.state.ma.us/dfa/pesticides/publications/IPM_kit_for_bldg_mgrs.pdf.

23. Consider adopting, the US EPA (2000) document, Tools for Schools, in order to provide self assessment and maintain a good indoor air quality environment at your building. The document can be downloaded from the Internet at *http://www.epa.gov/iaq/schools/index.html*.

24. For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH's website at *http://www.state.ma.us/dph/beha/iaq/iaqhome.htm*.

Long Term Recommendations

1. Leaks for weak joints in the heating system plumbing will continue to occur in the pattern as reported by Mr. Cotto, which would in turn cause damage to the suspended ceiling system and other building components. Consideration should be given to conducting a comprehensive study of the steam distribution system to affect a permanent repair of this system.
2. Continue with plans to replace roof. Ensure all roof leaks are repaired. Replace any remaining water-stained ceiling tiles. Examine the areas above and around these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
3. Local exhaust ventilation should be employed for the various activities noted in the technology shop.

References

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

CDC. 1998. Compendium of Measures to Control Chlamydia psittaci Infection Among Humans (Psittacosis) and Pet Birds (Avian Chlamydiosis), 1998. *MMWR 47:RR-10. July 10, 1998.*

Lstiburek, J. & Brennan, T. 2001. Read This Before You Design, Build or Renovate. Building Science Corporation, Westford, MA. U.S. Department of Housing and Urban Development, Region I, Boston, MA

Mass. Act. 2000. An Act Protecting Children and families from Harmful Pesticides. 2000 Mass Acts c. 85 sec. 6E.

MDPH. 1999. Indoor Air Quality Assessment Norfolk Probate Court, Dedham, Massachusetts. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.

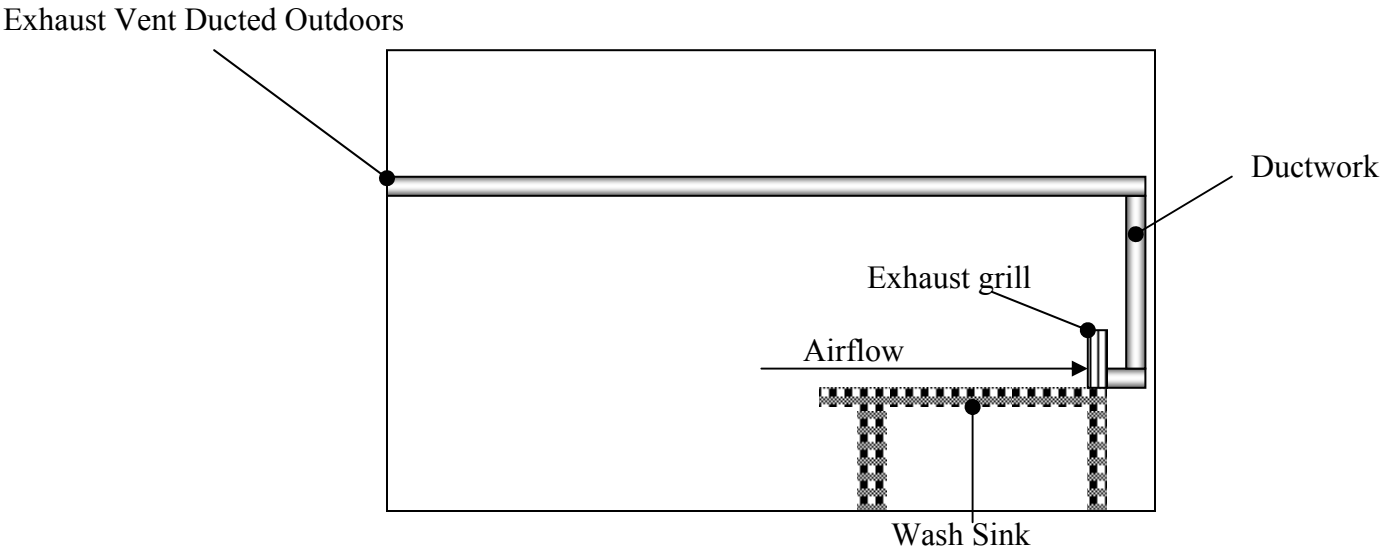
SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

Schmidt Etkin, D. 1992. Office Furnishings/Equipment & IAQ Health Impacts, Prevention & Mitigation. Cutter Information Corporation, Indoor Air Quality Update, Arlington, MA.

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

Figure 2

Suggested Reconfiguration of Dark Room Exhaust Ventilation



(Drawing is an example, not an actual representation)

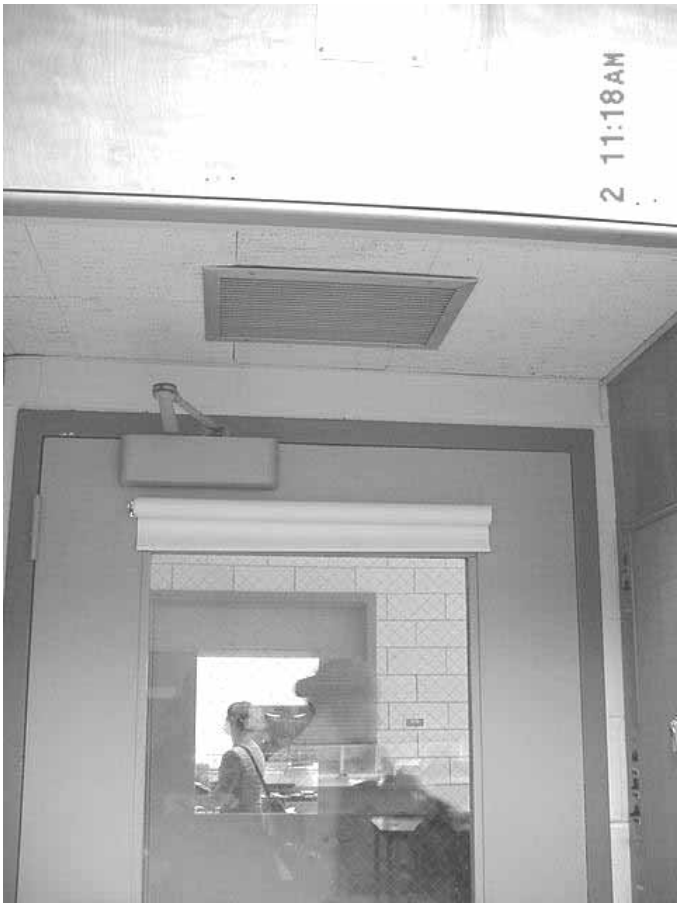
Picture 1

Univent Fresh Air Intake

Picture 2

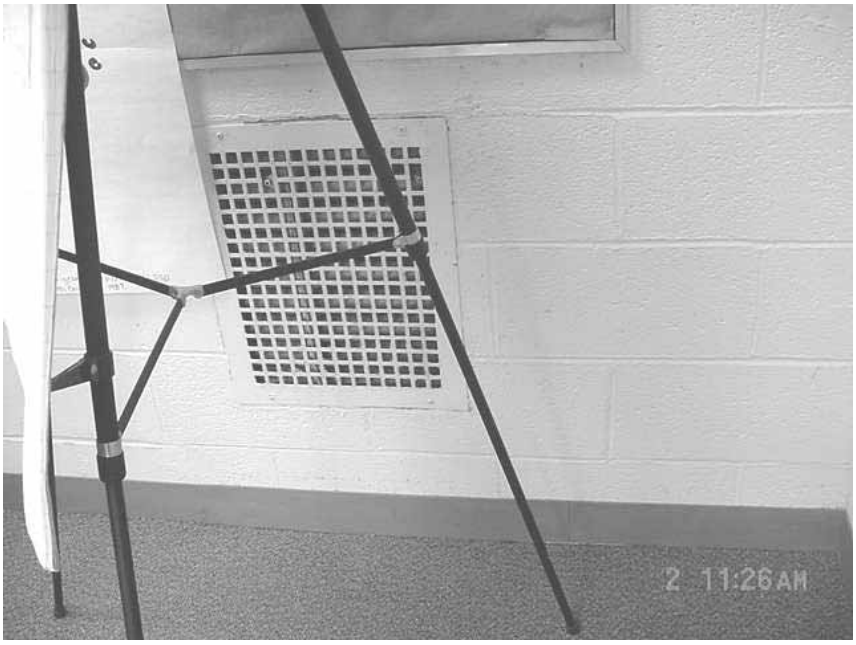
Univent Return Vent Obstructed By Classroom Items

Picture 3



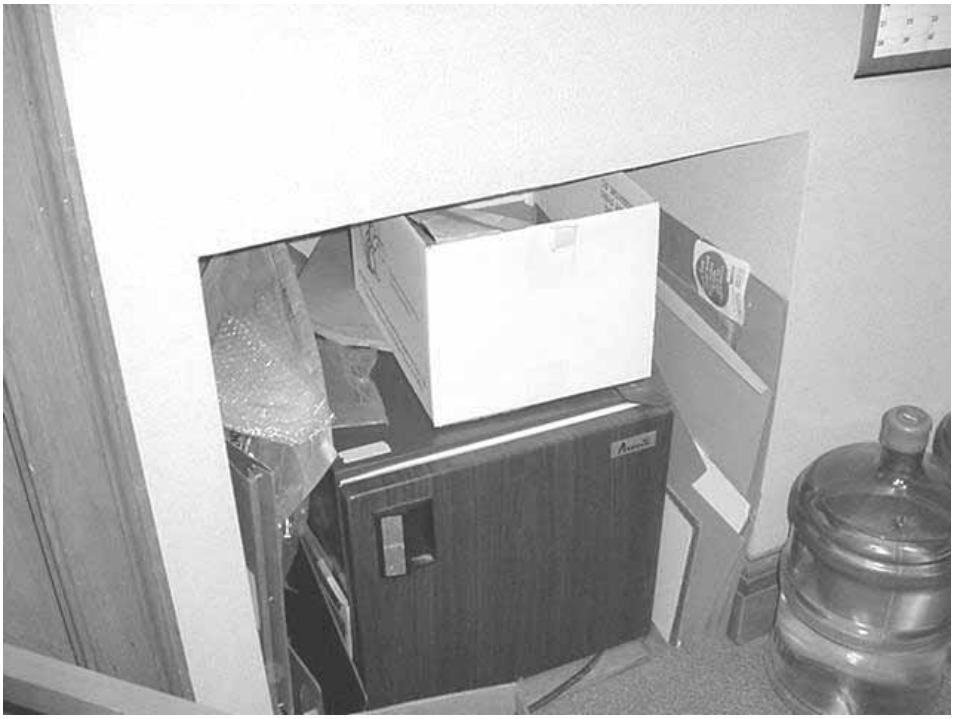
Ceiling-Mounted Exhaust Vent

Picture 4



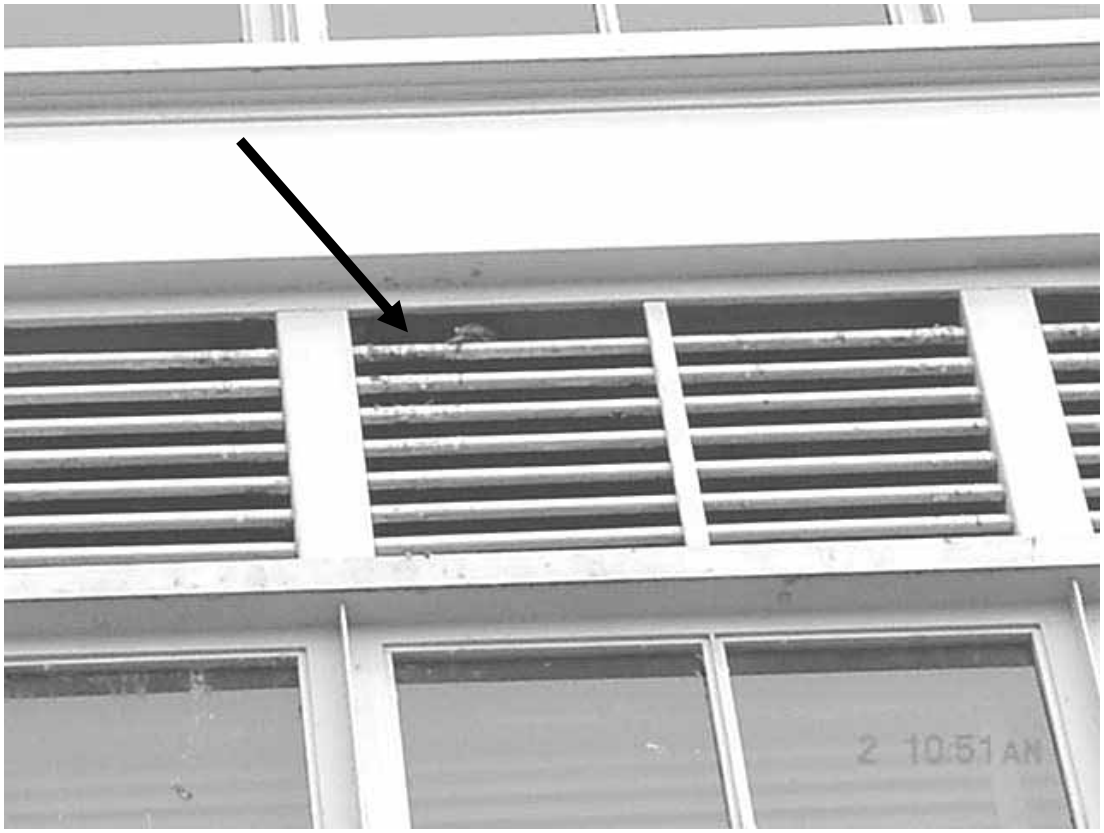
Wall-Mounted Exhaust Vent

Picture 5



Exhaust “Cubby” Used For Storage in Classroom

Picture 6



Birds and Wastes on Exterior of the Building

Picture 7

Missing/Water Damaged Ceiling Tiles

Picture 8

Tank in Basement That Leaked

Picture 9

Tree/Stump Growing Against Foundation

Picture 9A

Trees/Shrubs Growing Against Exterior Wall

Picture 10

Spaces around Utilities in Exterior Wall

Picture 11

Open Vent To Outside

Picture 12

Flowering Plants near Univent Air Diffuser

Picture 13

Mislabeled Wooden Cabinet That Is Used To Store Acids That Is Place On Top Of a Flameproof Cabinet

Picture 14

Fasteners in N the Chemical Storeroom Were Corroded From Off-Gassing Materials

Picture 15

A Highly Flammable Material, “Thermit”, Was Stored On an Open Shelf

Picture 16

Pesticide Container in Storeroom

Picture 17

Roof above Wood Shop

Wellesley Sr. High School
50 Rice Street, Wellesley MA 02481

Table 1

Indoor Air Results
March 2, 2004

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Outside (Background)	417	52	46					Cloudy/overcast, East wind ~ 5 mph
236	885	73	32	18	Y	Y UV	Y Wall Off/weak	CD, DEM; hallway door open
234	659	74	31	9	Y	Y UV	Y Wall	CD, DEM, PF, plants
325	1094	76	31	2	Y	Y UV	Y Wall Weak	DEM, 12 computers; hallway and inter-room doors open; burned out transformer
321	605	74	29	1	Y	Y UV	Y Cubby	DEM, PF, Cubby partly open
315	928	77	30	13	Y	Y UV	Y Cubby	CD, DEM, PF, plants; supply blocked by plants; exhaust blocked by boxes, clutter

ppm = parts per million parts of air
µg/m3 = microgram per cubic meter
WD = water damage
AD = air deodorizer
AP = air purifier

CD = chalk dust
DEM = dry erase marker
DO = door open
ND = non detect
PC = photocopier

PF = personal fan
TB = tennis balls
UF = upholstered furniture
UV = univent
CT = ceiling tile
MT/AT = missing/ajar tile

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

Wellesley Sr. High School
50 Rice Street, Wellesley MA 02481

Table 1

Indoor Air Results
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Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
313	695	78	27	0	Y	Y UV	Y Cubby	DEM, PF; hallway door open; supply occluded by dirt/debris, blocked by plants
309A	728	76	25	0		Passive door vent	Y Cubby ceiling	CD, inter-room door open
305	985	76	29	5	Y		Y Ceiling	DEM, PF, plants; hallway door open
303	671	74	29	1	Y		Y Ceiling	DEM, plants, hallway door open
201	532	73	31	1	Y	N	N	PC, PF; hallway door open; no exhaust for copier
209	885	75	34	17	Y	Y UV	Y Cubby	CD, DEM, PF, plants,; supply blocked by clutter

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						Supply	Exhaust	
213	458	75	31	2	Y	Y UV	Y Cubby	DEM, PF, plants; hallway door open; supply & exhaust blocked by clutter
Library	1208	75	28	~30	Y	Y weak Ceiling	Y off Ceiling	Plant(s) on carpet, dust, dust complaint on flat surfaces
144	470	75	32	2	Y	Y Ceiling	Y Cubby	DEM; 22 computers,
143	428	75	30	0	Y	Y Off UV	Y Ceiling	12 water damaged CT; hallway door open; exhaust occluded by dirt/debris
136	593	76	32	0		Y Ceiling	Y Ceiling	Exhaust occluded by dirt/debris
134	623	77	32	1	Y		N	PF, plants; hallway door open; window mounted AC
130	654	78	31	1		Y Ceiling	N	Water Damaged WP; window mounted AC

ppm = parts per million parts of air
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						Supply	Exhaust	
139	573	77	30	0	Y	N	N	Inter-room door open, leaking radiator, window-mounted AC
Guidance Hallway						Y ceiling		No exhaust for copier
Athletic Office	1002	75	32	1	y			1 MT/AT; AC, reports of active roof leaks
Home Economics	930	73	40	16	Y	Y Off UV	Y	2 UV's off
Nurse's Office	561	75	34	3	Y	N	N	
Gym	475	74	35	~50		Y Off Wall	Y Off Wall	Exterior door open
210	895	77	35	21	Y	Y Off UV	Y Off Wall	
212	1024	77	30	0	Y	Y Off UV	Y Wall	DEM, hallway door open, ~22 occupants gone 1 hr.

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237	950	76	33	20	Y	Y Off UV	Y Wall	DEM
235	1008	76	32	15	Y	Y Off UV	Y Wall	DEM, hallway door open; supply blocked by clutter
Faculty Dining Room	471	73	38	0	Y	Y UV		
50	483	71	38	12	Y	Y UV Ceiling	N	Hallway door open
331	995	75	34	23	Y	Y UV	Y Wall	DEM, hallway door open, supply blocked by clutter
332	869	74	33	8	Y	Y UV	Y Off Wall	Supply blocked by clutter, furniture
310 Faculty Lounge	733	72	31	12	Y	Y UV	Y Ceiling	Hallway door open; dirt, dust complaints from occupant; supply blocked by furniture

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308	572	73	31	1	Y	Y UV	Y Off Wall	~20 occupants gone 1 hr.
206	1061	76	34	23	Y	Y UV	Y Wall	Ex-sealed
205	1170	78	35	21	Y	Y UV	Y	Supply blocked by plants
179	840	73	30	0	Y	Y	Y	Chemical hoods-off, occupants gone 12 min
182	892	74	32	21	Y	Y	Y	DEM, incubator, chemical hood-off
180	840	74	31	11	Y	Y	Y	DEM, chemical hood
184	701	74	32	5	Y	Y	Y	
186	1146	76	32	5	Y	Y	Y	DEM, chemical hood, door open

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						Supply	Exhaust	
193	1006	75	33	21	Y	Y		2 CT
Hallway outside 193	1921	76	32	21	Y op	Y of	Y	CT-2, MT-2, wood shop odors
80 Woodshop	480	75	30	12	N	Y	Y	Door open
79 Auto shop	38	73	32	0	N	Y	Y	Dry trap, flame cabinet, asbestos tile
78 Technology	679	73	32	2	Y	Y	Y	Grinder, PVC cutting, soldering, flammables out of cabinet
71 Art	407	71	37	2	Y	Y	Y	Door open
69 Art	478	73	37	9	Y	Y	Y	
Pottery Room						Y	Y	3 Kilns beneath functioning hood

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53	546	76	32	18	Y	Y	Y off	Dirt in aquarium
Photocopy Room	541	77	33	2	Y	Y	Y	Door open
27 Darkroom	461	75	35	0	N	Y	Y off	Odor in hallway
Darkroom	404	74	36	0	N	Y	Y off	
329	1190	75	36	20	Y	Y UV	Y Off Wall	DEM, exhaust-backdraft
330	1602	77	37	22	Y	Y Off UV	Y Off Wall	DEM
231	635	76	30	1	Y	Y UV	Y Wall	Hallway door open;14 occupants gone ~45 min.; DEM particulate
328 Office	759	76	30	0		Y Ceiling	Y Ceiling	Bubbler over carpet; hallway door open

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316	645	76	33	1		N	Y Ceiling	DEM, hallway door open; recommend passive vent in door
334	1250	375	34	19	Y	Y UV	Y Off Wall	Broken window frame
43	621	75	40	27	Y	Y UV Ceiling	N	4 water damaged CT
244	693	75	31	4	Y	Y UV	Y Off	1 water damaged CT, hallway door open; supply blocked by clutter
239	837	75	33	0	Y	Y UV	Y Off Wall	DEM; supply blocked by clutter
214	1804	76	32	21	Y	Y UV	Y Wall	DEM, Passive exhaust vent
Main Office	633	74	32	4	Y	N	N	

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Data processing	634	75	32	0		Y Ceiling	N	Hallway door open
125						N	N	PC; hallway door open
Boys' Locker Room	417	73	35	0		Y Ceiling	Y Ceiling	
42 Wrestling Room	542	81	30	0	Y	Y UV Ceiling	Y Wall	Local ex vent, overheating issues
Mezzanine & Cafeteria						Y UV	Y Wall	5 water damaged CT, 3 MT/AT; exterior door open; supply blocked by clutter, occluded by dirt/debris
Foods Lab	719	72	46		Y	Y UV		Clothes dryer; stovetop ex

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141	498	76	31	0	Y	Y Ceiling	Y Cubby	1 water damaged CT, plants on carpet, bubbler over carpet; inter-room door open; window mounted AC
142	825	75	31	0		Y UV	N	Plants; supply blocked by plants
138	520	77	32	0	Y			Inter-room door open, window mounted AC
137	466	76	32	1	Y	N	N	Plants, hallway door open; window mounted AC
145	446	76	30	0	Y	Y Ceiling	N	10 Water damaged CT; DEM
146	463	29	78	0	Y	Y Ceiling	Y Cubby	DEM, inter-room door open; 16 computers
225	983	76	30	5	Y	Y UV	Y off-BD	CD, PF, plants; hallway and inter-room doors open

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225B	993	75	30	0	Y	N	N	DEM, inter-room door open
215	487	76	29	1	Y	Y UV	Y Cubby	CD, PF, hallway door open; supply blocked by plants, exhaust blocked by clutter
217	816	78	29	1	Y	N	N	Plants; hallway door open
205	972	76	34	11	Y	Y Off UV	Y Cubby	DEM, PF, plants; exhaust blocked by clutter
207	659	73	33	20	Y	Y Off UV	Y Cubby	CD, PF, plants; hallway door open
309B	949	77	28	5	Y		Y Ceiling	Carpet; DEM, plants; inter-room door open
307A	941	77	27	4	Y	Y Off UV	N	PF Supply UV broken

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311	745	75	29	15	Y	Y UV	Y Cubby	DEM, PF; hallway door open
307B	859	76	27	3	Y	N	N	PF
317	670	75	29	0		Y Ceiling		Bubbler over carpet; PF, Hallway & inter-room doors open; temp complaints
319	621	75	28	2	Y	N	N	PF, plants; hallway door open; window mounted AC
232	502	75	29	0		Y UV	Y Wall	CD
Main Band Room	1585	75	33	~50	Y	Y Off UV	Y Wall	2 MT/AT; CD; exhaust blocked by furniture

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245	642	74	28	3	Y	Y Uni	Y Ceiling above door	2 water damaged CT; CD, DEM, TB; hallway door open; roof replacement over next 2 years; supply blocked by furniture & clutter
238	608	72	32	23	Y	Y UV	Y Wall	CD; supply blocked by furniture

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